

DOCKET NO.: 4568  
INVENTORS: Klaus-Hinrich BORCHERS

USPS EXPRESS MAIL  
EV 338 198 442 US  
SEPTEMBER 08 2003

TITLE OF THE INVENTION

Protection Hose Arrangement for Conductors  
Installed in an Aircraft

PRIORITY CLAIM

5 This application is based on and claims the priority under 35  
U.S.C. §119 of German Patent Application 102 41 573.0-22, filed  
on September 7, 2002, the entire disclosure of which is  
incorporated herein by reference.

FIELD OF THE INVENTION

10 The invention provides additional protection for electrically  
insulated electrical conductors installed in a vehicle,  
particularly an aircraft.

BACKGROUND INFORMATION

15 The installation of insulated electrical conductors in a  
protection device such as a tubular or hose member provides one  
possibility, among several, for protecting the conductors against  
external mechanical adverse influences. Such adverse influences  
are, for example, caused by the transmission of vibrations which

scour the electrical insulation thereby damaging the insulation, which in turn may lead to further problems such as moisture entering into the electrical conductors through the damaged insulation. The exposure of the electrical conductors to  
5 external electromagnetic interferences and/or other electrical effects also requires protection for the conductors.

It is conventional to install electrically insulated conductors in individual hoses or tubular members. Such installation technology is, for example, used in all aircraft models  
10 manufactured by "Airbus". In such wiring installations efforts are made to install or distribute the conductors with due regard to the route or connection for which the particular conductor is intended. For example, such routes or connections may run from a central control unit to a plurality of controlled units or from  
15 an electrical power source to a plurality of electrical power consumers in an aircraft. Separate wiring routes may be provided for communication purposes.

Due to the multitude of connections or routes that must be established within an aircraft and due to the limited space  
20 available in an aircraft for such installations it becomes quite a challenge for the maintenance and repair crews to clearly distinguish individual conductors in the multitude of electrical conductors installed in individual protective tubular members or hoses. A wrong connection may have disastrous effects.  
25 Moreover, due to the limited space available for the wiring it becomes frequently necessary to position different conductor

routes or connections quite closely to one another by installing different conductors and/or conductor bundles above one another and/or next to one another. Such close installation requires a bundling of a plurality of individual protective hoses. Such  
5 bundling of a plurality of individual protective hoses is realized with cable binders or cable mounting bracket, whereby a plurality of such binders or brackets must be positioned along the length of a plurality of protective hoses for connecting these hoses to the aircraft structure. Accordingly, the  
10 maintenance personnel working inside the aircraft faces a quite confusing image of a multitude of wires which makes it difficult even for an experienced maintenance man to clearly sort out the various conductor routes. This conventional situation makes it quite difficult to perform repair operations or to conduct  
15 scheduled maintenance and monitoring work on the electric installation or wiring in an aircraft.

#### OBJECTS OF THE INVENTION

In view of the foregoing it is the aim of the invention to achieve the following objects singly or in combination:

20 to construct a protection or guard hose for protecting electrically insulated conductors in such a way that a defined separation of routes or electrical connections is assured when electrical signal conductors, electrical control conductors, and electrical power supply conductors are installed in such guard  
25 hose arrangements;

to reduce the effort and expense for repair work and for scheduled installation and monitoring work of the electrical wiring system in an aircraft or any other conveyance, such as a ship;

5           to facilitate the installation of a multitude of electrical conductors in an aircraft, thereby also improving the attachment of the electrical conductors to the aircraft frame structure; and

to interconnect a plurality of protection or guard hoses with spacers to save space; and

10           to avoid an uncontrolled movement of individual insulated electrical conductors.

#### SUMMARY OF THE INVENTION

The above objects have been achieved according to the invention by a guard hose arrangement for protecting insulated electrical  
15           conductors for installation in a vehicle such as an aircraft, wherein the guard or protection hose arrangement comprises a plurality of guard hoses, each of which has an inner diameter for receiving at least one, preferably a multitude of the insulated electrical conductors, and wherein each guard hose comprises an  
20           outwardly facing first contour along its length for connection to at least one spacer which has a second contour for cooperation with the outwardly facing first contour of the guard hose. This spacer is or spaces are positioned between two neighboring guard

hoses of said plurality of guard hoses. One or many spacers may be positioned between two neighboring guard hoses and the number of guard hoses is not limited except for practical purposes, whereby these hoses are precisely spaced from one another along  
5 any desired length. At least two guard hoses are interconnected by at least one spacer.

The plurality of guard hoses may be interconnected by their spacer or spacers while these hoses are manufactured to thereby produce an integral structure of at least two, preferably more,  
10 guard hoses spaced by a spacer or spacers. Preferably, the spacers are provided with cut-outs or through holes that may have different shapes to reduce the weight of these guard hose arrangements. However, manufacturing the guard hoses and the spacers separately for a subsequent interconnection is also  
15 possible, whereby the connection is, for example, performed by welding, adhesive bonding, and other suitable connections such as inserting the spacer or spacers in a groove of the guard hoses in a tongue and groove arrangement. Preferably, the spacers and the guard hoses are made of polytetrafluoroethylene (PTFE) in  
20 accordance with prescribed standards such as "NSA935805".

#### BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be clearly understood, it will now be described in detail in connection with example embodiments thereof, with reference to the accompanying drawings, wherein:

Fig. 1 is an end view of a guard hose arrangement with two guard hoses;

Fig. 2 is a similar end view illustrating an in-line arrangement of four guard hoses held uniformly spaced from each other by three spacer devices;

Fig. 3 shows a perspective view of the arrangement of Fig. 1;

Fig. 4 shows a spacer with a cut-out or hole to reduce weight and to facilitate the mounting;

Fig. 5 is a perspective view of two spacer members arranged in a row spaced from one another and having larger concave surfaces for spacing guard hoses having a correspondingly larger diameter;

Fig. 6 is a perspective view of a plurality of guard hoses with a cross-sectional configuration other than circular and arranged vertically;

Fig. 7 is a perspective view of a spacer intended for forming a spacer with an angular sectional configuration;

Fig. 7A shows a spacer having said angular sectional configuration;

Fig. 8 is a perspective schematic view of a spacer having approximately a U-cross-sectional configuration;

Fig. 9 is a side view of two different guard hoses interconnected by a plurality of individual spacers;

5 Fig. 10 is a view in the direction of the arrow X in Fig. 9;

Fig. 11 is a view similar to that of Fig. 9, but illustrating a single spacer with a plurality of cut-outs; and

Fig. 12 is a view in the direction of the arrow XII in Fig. 11.

10 DETAILED DESCRIPTION OF A PREFERRED EXAMPLE EMBODIMENT AND OF THE BEST MODE OF THE INVENTION

In this context the term "protection hose" and the term "guard hose" are used as synonyms. These terms are intended to cover all tubular material capable of holding and protecting  
15 electrically insulated conductors.

Fig. 1 shows an end view of two guard hoses 1 and 2 spaced from each other by a spacer 5 connected at its upper end at a junction 6 to the guard hose 1. The spacer 5 is connected at a junction 7 to the lower guard hose 2. Each guard hose 1, 2 holds a  
20 plurality of insulated electrical conductors 4 merely symbolically shown by randomly positioned dots. The guard hose

arrangements according to the invention may be oriented vertically or in any other position as required by the installation conditions in an aircraft. The guard hoses 1 and 2 and the spacer or spacers 5 are preferably made of synthetic materials such as PTFE.

Fig. 2 is a view similar to Fig. 1 illustrating a plurality of guard hoses 1, 2, 3...n. Each of these guard hoses holds a plurality of electrical conductors 4 that are individually electrically insulated. The number of required spacers in the embodiment of Fig. 2 corresponds to  $n - 1$ .

Fig. 3 illustrates that the longitudinal axes 8 of the guard hoses 1 and 2 preferably extend in parallel to each other and that the spacer 5 has a length that corresponds substantially to a straight length A of the guard hoses 1 and 2. Fig. 3 further illustrates that the guard hoses 1 and 2 have an outer first contour C1 shaped to conform with a second contour C2 of the spacer 5. The second contour C2 is best seen in Fig. 4. In the shown examples the first contours C1 are convex and the second contours C2 are correspondingly concave so that the contours C2 fit snugly in full surface contact against the first contours C1 of the guard hoses 1 and 2. However, the invention is not limited to the convex and concave contours as shown in the example embodiment of Figs. 3 and 4. Other matching contours can be employed along the junctions 6 and 7 between the guard hoses and the spacer or spacers. For example, tongue and groove



contours could be used to interconnect the spacer or spacers with the guard hoses.

Fig. 4 shows that the spacer 5 has substantially the shape of a parallelepiped except that two opposing sides are contoured as shown at C2 while the other sides such as the bottom side S1, the top side S2 and the end faces S3 and S4 are plane surfaces. Further, it is preferred to provide the spacers 5 with holes or cut-outs 9 that pass entirely through the spacer 5 to thereby reduce the weight of the spacers and to facilitate the mounting of the guard hose or protection hose arrangement.

Fig. 5 shows two spacers 5A and 5B arranged in a row and spaced from each other by a spacing S. The second contours C2 are now formed on the large surface areas S1 and S2 rather than on the side surfaces S5 and S6. This type of spacer is suitable for use with guard hoses having a larger outer diameter and which may be narrowly spaced from one another. In the example of Fig. 5 the opposing side surfaces S5 and S6 and the end surfaces S7 and S8 preferably remain as flat surfaces.

Fig. 6 shows a perspective view of a plurality of guard hoses 1', 2', n' that do not necessarily have a circular cross-sectional configuration. A square configuration or a polygonal cross-sectional configuration is also suitable, whereby the junctions 6 and 7 are again shaped to assure a proper surface area contact between spacers and hoses. Further, the connection

between spacers and hoses may, for example be formed by welding seams WS or by adhesive bonding.

Figs. 7 and 7A illustrate the formation of an angled spacer 5A shown in Fig. 7A. The flat spacer blank of Fig. 7 has a length B between the end edges with the second contours C2. The blank also has a width C which may correspond to the straight length A of the guard hoses shown in Fig. 3. According to the invention the blank of Fig. 7 is bent into an angle section shown in Fig. 7A. Preferably, the bending will take place along a centerline, or rather a preformed bending line BL so that the resulting legs of the angular section L1 and L2 will be approximately one half of the length B. These legs L1, L2 may be provided with cut-outs 9' for reducing the weight of the spacers 5A and facilitating the mounting. The legs L1 and L2, however, also may have different lengths depending on the installation conditions to be satisfied. An angle  $\alpha$  enclosed by the legs L1, L2 is preferably within the range of  $45^\circ$  to  $90^\circ$ . The bending line BL runs, for example, along a reduced thickness of the spacer blank of Fig. 7.

It is to be understood that spacers 5A with an angular cross-section as shown in Fig. 7A may also be formed without any bending, for example by extrusion or molding techniques. In any event, the length of the legs L1 and L2, as well as the angle  $\alpha$  will be selected with due regard to the installation requirements. This also applies to the position and number of the holes 9'.

Fig. 8 shows schematically a spacer 5B having two side flanges SF1 and SF2 interconnected by a land L. The side flanges SF1 and SF2 enclose with the land L an angle  $\beta$  that is preferably  $120^\circ$ . However, and again depending on the installation requirements, the angle  $\beta$  may be selected, for example within the range of  $90^\circ$  to  $150^\circ$ . The side flanges SF1 and SF2 carry at their free edges the above described contours C2 for matching with respective contours on the surface of guard hoses not shown in Fig. 8. The land L and the side flanges SF1, SF2 are preferably also provided with through holes, whereby particularly through holes in the land L will facilitate the securing of the spacers with the guard hoses to the aircraft frame structure. The contours C2 in Fig. 8 may, for example, be tongues shaped for cooperation with respective grooves in the guard hoses.

Referring to Figs. 9 and 10, two different protective hoses 1A and 2A are interconnected by a plurality of spacers 5, for example as shown in Fig. 4. The protective or guard hose 1A is covered by a protective coating 10 which preferably covers the entire surface of the guard hose 1A except where the surface of the guard hose 1A is connected to the spacers 5 at the junction 6. The protective coating may, for example be a textile fabric that is slotted in its longitudinal direction so that it may be slipped onto the guard hose 1A. The protective coating 10 may also be a metal foil or a coating having metal particles incorporated in the coating for protecting the electrical conductors 4 against adverse electromagnetic influences. Preferably, the protective coating 10 in the form of a textile

5 fabric is provided on its radially inwardly facing surface with a self-adhesive so that the coating 10 will adhere to the outer surface of the guard hose 1A. The spacers 5 are provided with the cut-outs 9 as described above. The cut-outs or holes 9 may have any desired configuration adapted to the shape and other dimensions of the respective spacers 5.

10 The second guard hose 2A is provided with welts 11 that extend longitudinally or preferably helically around the guard hose 2A. These welts 11 may themselves be hollow or solid and protect the guard hose 2A against adverse mechanical influences. Such hoses may, for example be formed by extrusion molding or the like in accordance with the above mentioned standard.

15 Figs. 11 and 12 show an embodiment in which a single spacer 5 provided with circular cut-outs 9' holds two guard hoses 1B and 2A together, whereby both guard hoses are of the same construction as described above with reference to the guard hose 2A shown in Figs. 9 and 10. The protective welts 11 shown in Fig. 9 for the lower guard hose 2A and in Fig. 11 for both guard hoses 1B and 2A are merely shown symbolically as running parallel to the length of the respective guard hose. However, it is to be understood, that these welts 11 may run helically along the respective guard hose except where the junctions 6 and 7 are.

20 Although the guard hoses have been shown to be of equal diameter, it is quite possible to connect guard hoses of different

diameters to each other through the described spacers according to the invention.

While the integral formation of the guard hoses and spacers is preferred, a separate production may be advantageous under certain installation requirements, whereby an adhesive bonding, welding, or mechanical interconnection may be preferred over the integral formation of the guard hoses with the spacers. In any of these embodiments the length of the guard hose arrangement according to the invention may be quite substantial, whereby the material can be rolled up for storage and sections of required length may then be cut during installation. Further, the protective coating may be a paint coating in which metallic particles are distributed for achieving the desired mechanical, as well as protection against adverse electromagnetic influences.

Although the invention has been described with reference to specific example embodiments, it will be appreciated that it is intended to cover all modifications and equivalents within the scope of the appended claims. It should also be understood that the present disclosure includes all possible combinations of any individual features recited in any of the appended claims.